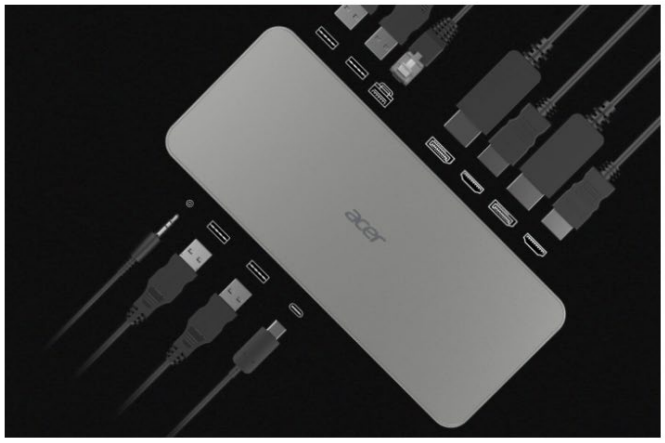
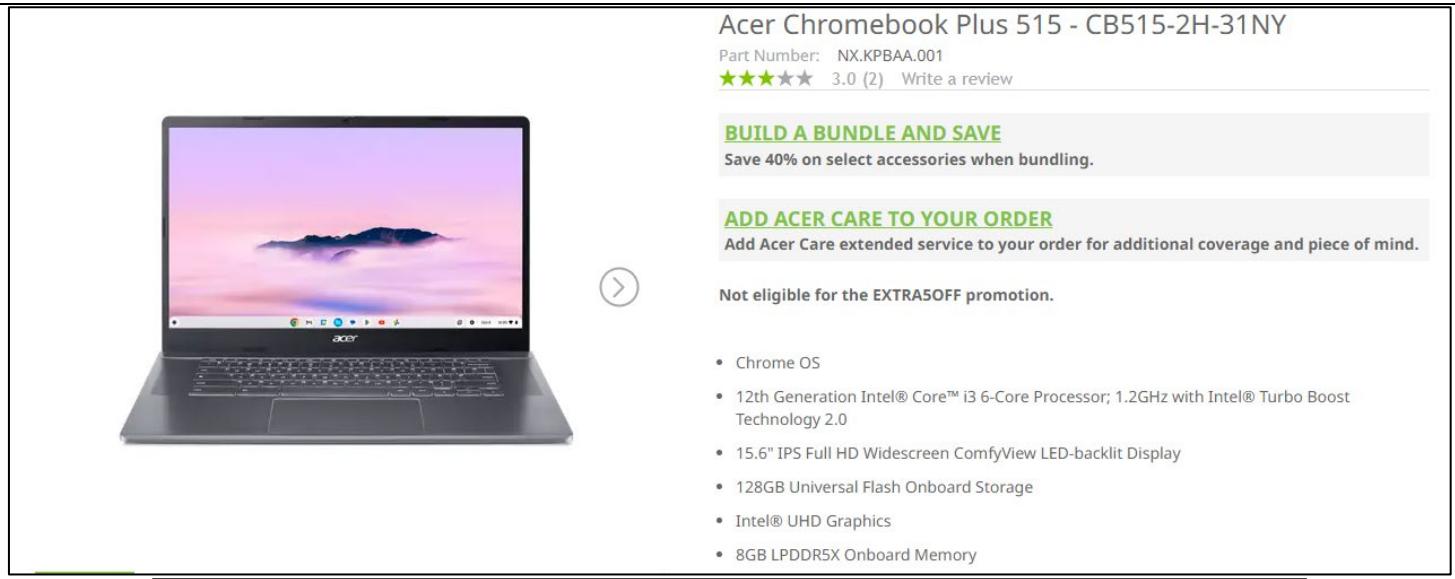
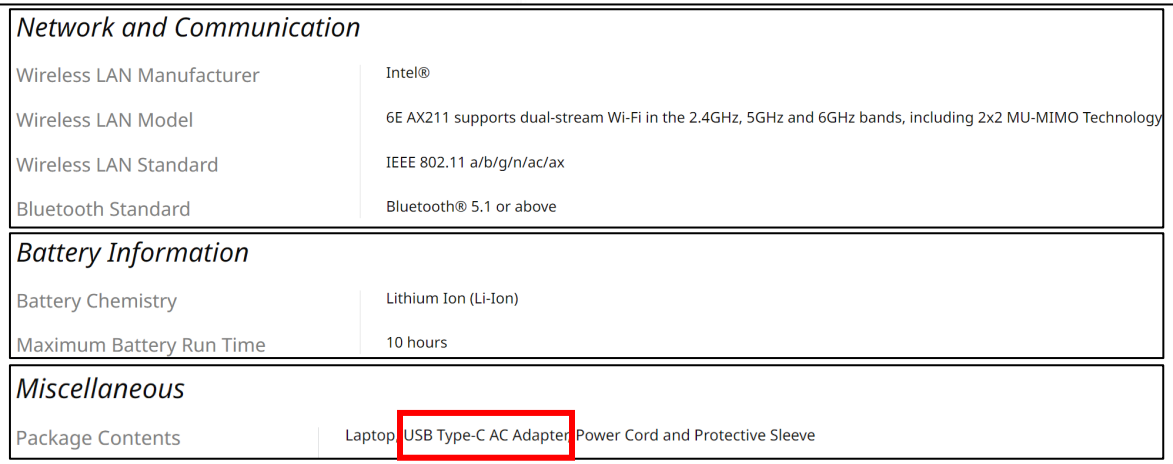
Exhibit 7: U.S. Patent No. 8,610,397

Claim	Identification
1[pre] A battery charger for a portable wireless communications device, the portable wireless communications device including a rechargeable battery and a wireless communications transceiver coupled thereto, the portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types having respective charging rates, the battery charger comprising:	To the extent the preamble is limiting, Acer-branded devices include a battery charger for a portable wireless communications device, the portable wireless communications device including a rechargeable battery and a wireless communications transceiver coupled thereto, the portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types having respective charging rates.  Acer USB Type-C Dock D501 - ADK020 Part Number: GP.DCK11.00E ★★☆☆☆ 2.0 (1) Write a review • Certified by Works With Chromebook • Gigabit Ethernet connectivity • 1 x USB Type C with power charging; 4 x USB 3.2 Gen 1 Type-A ports; 2 x USB 3.1 Gen 2 Type-A Ports • Supports up to 3 displays using 1 x HDMI 2.0/DisplayPort 1.4; 1 x HDMI 2.0; 1 x DisplayPort 1.4 • 1 x 3.5mm Audio port Universal USB-C Dock Charge your Chromebook, transfer data, extend your display, and enable peripherals such as speakers or Gigabit Ethernet with just single USB-C cable. The docking station's USB-C Power Delivery can charge your laptop with up to 60W of power through the USB-C connection. 

Claim	Identification





See, e.g., *Acer USB Type-C Dock D501 - ADK020*, Acer, https://store.acer.com/en-us/acer-usb-type-c-dock-d501-adk020?gad_source=1&gclid=EAIaIQobChMI3uLs-quphAMVmgytBh23VQwhEAQYASABEgK-nPD_BwE (last visited Mar. 7, 2024); *Acer USB Type-C Dock D501 – Certified by Works With Chromebook*, Acer, https://www.acer.com/us-en/accessories/for-chromebooks/acer-usb-type-c-dock-501 (last visited Mar. 7, 2024); *Acer Chromebook Plus 515 - CB515-2H-31NY*, Acer, https://store.acer.com/en-us/acer-chromebook-plus-515-cb515-2h-31ny (last visited Mar. 8, 2024).

Claim	Identification

Acer Iconia Tab M10 Tablet - M10-11-K5N0

Part Number: NT.LFUAA.001

★★★★★ 5.0 (1) Write a review

- Android
- MediaTek MT8183C Cortex-A73/A53 multi-processor
- Integrated graphics
- 10.1" WUXGA (1920 x 1200) IPS touchscreen display
- 4 GB standard memory; 128 GB Flash storage
- Wi-Fi 5, Bluetooth 5.2 & GPS

Network & Communication

Wireless LAN Standard	IEEE 802.11 a/b/g/n/ac/ax
Bluetooth Standard	Bluetooth 5.0 & GPS

Battery

Battery Chemistry	Lithium Ion (Li-Ion)
Maximum Battery Run Time	9 hours

Miscellaneous

Package Contents	Iconia Tab M10 Tablet; USB Type-C Adapter & Power Cord; Transparent Bumper Case

See, e.g., *Acer Iconia Tab M10 Tablet - M10-11-K5N0*, Acer, https://store.acer.com/en-us/acer-iconia-tab-m10-tablet-m10-11-k5n0 (last visited Mar. 8, 2024).

ACER ANSWERS › TABLET

Acer Android Tablet USB Type-C Port Features

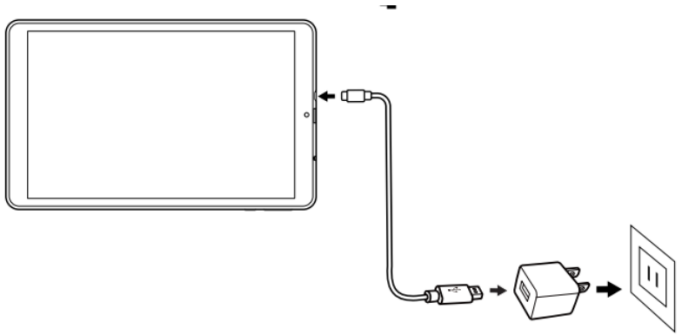
By **Acer-Chantal** Last Updated: **Nov 1, 2023**

Acer Iconia A10, M10 and P10 Android tablets include a multi-purpose USB type-C port to allow for charging the tablet or connecting to a computer to transfer data.

Claim	Identification

Charging your tablet

1. Plug the provided charging cable into the micro USB port on your device.
2. Then plug the USB connector of the charging cable into the 10 w AC adapter block.
3. Finally, plug the AC adapter block into a wall outlet.



Your device is now connected to the wall outlet and will start charging.

See also, e.g., Acer-Chantal, *Acer Android Tablet USB Type-C Port Features*, Acer (Nov. 1, 2023), https://community.acer.com/en/kb/articles/16561-acer-android-tablet-usb-type-c-port-features.

1.1 Overview

This specification defines how USB Devices can negotiate for more current and/or higher or lower voltages over the USB cable (using the USB Type-C CC wire as the communications channel) than are defined in the ***[USB 2.0]***, ***[USB 3.2]***, ***[USB Type-C 1.3]*** or ***[USBBC 1.2]*** specifications. It allows Devices with greater power requirements than can be met with today's specification to get the power they require to operate from V_{BUS} and negotiate with external power sources (e.g. Wall Warts). In addition, it allows a Source and Sink to swap power roles such that a Device could supply power to the Host. For example, a display could supply power to a notebook to charge its battery.

Claim	Identification

To facilitate optimum charging, the specification defines two mechanisms a USB Charger can advertise for the Device to use:

1. A list of fixed voltages each with a maximum current. The Device selects a voltage and current from the list. This is the traditional model used by Devices that use internal electronics to manage the charging of their battery including modifying the voltage and current actually supplied to the battery. The side-effect of this model is that the charging circuitry generates heat that may be problematic for small form factor devices.
2. A list of programmable voltage ranges each with a maximum current (PPS). The Device requests a voltage (in 20 mV increments) that is within the advertised range and a maximum current. The USB Charger delivers the requested voltage until the maximum current is reached at which time the USB charger reduces its output voltage so as not to supply more than the requested maximum current. During the high current portion of the charge cycle, the USB Charger can be directly connected (through an appropriate safety device) to the battery. This model is used by Devices that want to minimize the thermal impact of their internal charging circuitry.

1.2 Purpose

The USB Power Delivery specification defines a power delivery system covering all elements of a USB system including: Hosts, Devices, Hubs, Chargers and cable assemblies. This specification describes the architecture, protocols, power supply behavior, connectors and cabling necessary for managing power delivery over USB at up to 100W. This specification is intended to be fully compatible and extend the existing USB infrastructure. It is intended that this specification will allow system OEMs, power supply and peripheral developers adequate flexibility for product versatility and market differentiation without losing backwards compatibility.

USB Power Delivery is designed to operate independently of the existing USB bus defined mechanisms used to negotiate power which are:

- ***[USB 2.0]***, ***[USB 3.2]*** in band requests for high power interfaces.
- ***[USBBC 1.2]*** mechanisms for supplying higher power (not mandated by this specification).
- ***[USB Type-C 1.3]*** mechanisms for supplying higher power

1.6 Terms and Abbreviations

This section defines terms used throughout this document. For additional terms that pertain to the Universal Serial Bus, see Chapter 2, "Terms and Abbreviations," in ***[USB 2.0]***, ***[USB 3.2]***, ***[USB Type-C 1.3]*** and ***[USBBC 1.2]***.

PD	USB Power Delivery
PD Capable	A Port that supports USB Power Delivery.
PD Connection	See Connected.
PD Power (PDP)	The output power of a Source, as specified by the manufacturer and expressed in Fixed Supply PDOs as defined in Section 10.
PDP Rating	Manufacturer declared PDP for a Source.
PDUSB	USB Device Port or USB Host Port that is both PD capable and capable of USB Communication. See also PDUSB Host, PDUSB Device and PDUSB Hub.
PDUSB Device	A USB Device with a PD Capable UFP. A PDUSB Device is only addressed by SOP Packets.

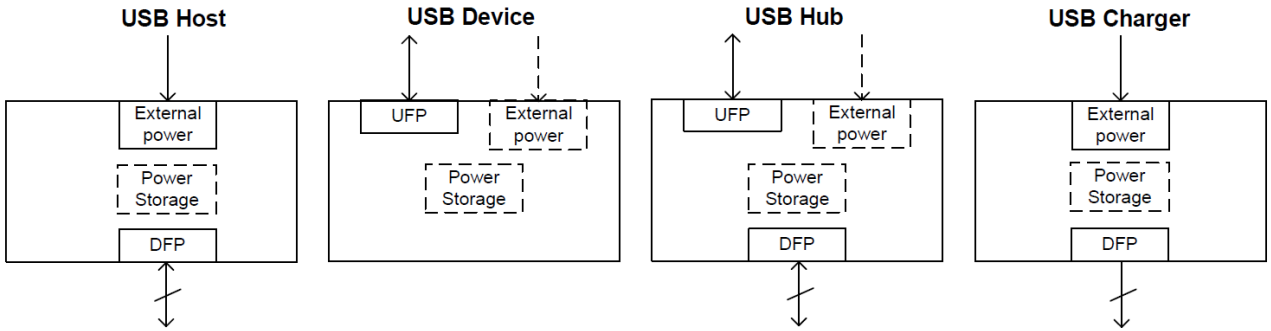
Claim	Identification

PDUSB Host	A USB Host which is PD Capable on at least one of its DFPs. A PDUSB Host is only addressed by SOP Packets.
PDUSB Hub	A port expander USB Device with a UFP and one or more DFPs which is PD Capable on at least one of its Ports. A PDUSB Hub is only addressed by SOP Packets.
PDUSB Peripheral	A USB Device with a PD Capable UFP which is not a PDUSB Hub. A PDUSB Peripheral is only addressed by SOP Packets.
Sink	The Port consuming power from V_{BUS}; most commonly a Device.
Source	A role a Port is currently taking to supply power over V_{BUS}; most commonly a Host or Hub downstream port.
USB Device	Either a hub or a peripheral device as defined in ***[USB 2.0]*** and ***[USB 3.2]***.
USB Host	The host computer system where the USB host controller is installed as defined in ***[USB 2.0]*** and ***[USB 3.2]***.

2.4 USB Power Delivery Capable Devices

Some examples of USB Power Delivery capable devices can be seen in Figure 2-1 (a Host, a Device, a Hub, and a Charger). These are given for reference only and do not limit the possible configurations of products that can be built using this specification.

Figure 2-1 Logical Structure of USB Power Delivery Capable Devices



Claim	Identification

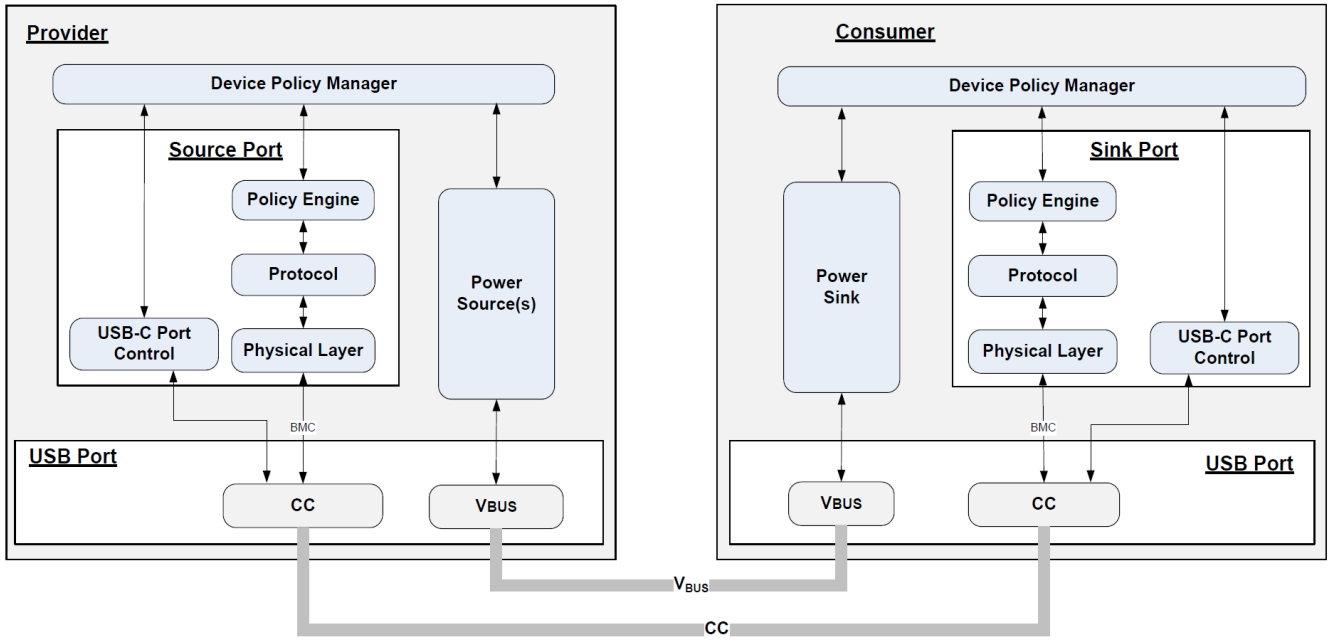
2.7 Architectural Overview

Figure 2-5 shows the logical blocks between two Attached PD ports. In addition to the communication stack described above there are also:

- For a Provider or Dual-Role Power Device: one or more **Sources** providing power to one or more ports.
- For a Consumer or Dual-Role Power Device: A **Sink** consuming power.
- A **USB-C Port Control** module (see Section4.4) that detects cable Attach/Detach as defined in ***[USB Type-C 1.3]***.
- USB Power Delivery uses standard cabling as defined in ***[USB Type-C 1.3]***.

The **Device Policy Manager** talks to the communication stack, Source/Sink and the USB-C Port Control block in order to manage the resources in the Provider or Consumer.

Figure 2-5 High Level Architecture View



Claim	Identification

6.4.1.3 Sink Capabilities Message

A Sink Port ***Shall*** report power levels it is able to operate at in a series of 32-bit Power Data Objects (see Table 6-7). These are returned as part of a ***Sink_Capabilities*** Message in response to a ***Get_Sink_Cap*** Message (see Figure 6-12). This is similar to that used for Source Port capabilities with equivalent Power Data Objects for Fixed, Variable and Battery Supplies as defined in this section. Power Data Objects are used to convey the Sink Port's operational power requirements including Dual-Role Power Ports presently operating as a Source.

Each Power Data Object ***Shall*** describe a specific Sink operational power level, such as a Battery (e.g. 2.8-4.1V) or a fixed power supply (e.g. 12V). The ***Number of Data Objects*** field in the Message Header ***Shall*** define the number of Power Data Objects that follow the Message Header in a Data Message.

All Sinks ***Shall*** minimally offer one Power Data Object with a power level at which the Sink can operate. A Sink ***Shall Not*** offer multiple Power Data Objects of the same type (fixed, variable, Battery) and the same voltage but ***Shall*** instead offer one Power Data Object with the highest available current for that Sink capability and voltage.

All Sinks ***Shall*** include one Power Data Object that reports ***vSafe5V*** even if they require additional power to operate fully. In the case where additional power is required for full operation the Higher Capability bit ***Shall*** be set.

6.4.1.3.1 Sink Fixed Supply Power Data Object

Table 6-14 describes the Sink Fixed Supply (00b) PDO. See Section 7.1.3 for the electrical requirements of the power supply. The Sink ***Shall*** set Voltage to its required voltage and Operational Current to its required operating current. Required operating current is defined as the amount of current a given device needs to be functional. This value could be the maximum current the Sink will ever require or could be sufficient to operate the Sink in one of its modes of operation.

Since all USB Consumers support ***vSafe5V***, the required ***vSafe5V*** Fixed Supply Power Data Object is also used to convey additional information that is returned in bits 29 through 20. All other Fixed Supply Power Data Objects ***Shall*** set bits 29...20 to zero.

For a Sink requiring no power from the Source, the Voltage (B19...10) ***Shall*** be set to 5V and the Operational Current ***Shall*** be set to 0mA.

6.4.4.3.1 Discover Identity

The ***Discover Identity*** Command is provided to enable an Initiator to identify its Port Partner and for an Initiator (VCONN Source) to identify the Responder (Cable Plug). The ***Discover Identity*** Command is also used to determine whether a Cable Plug is PD-Capable by looking for a ***GoodCRC*** Message Response.

The ***Discover Identity*** Command ***Shall*** be used to determine whether a given Cable Plug is PD Capable (see Section 8.3.3.18.1 and Section 8.3.3.22.3). In this case a ***Discover Identity*** Command request sent to SOP' ***Shall Not*** cause a Soft Reset if a ***GoodCRC*** Message response is not returned since this can indicate a non-PD Capable cable. Note that a Cable Plug will not be ready for PD Communication until tVCONNStable after VCONN has been applied (see ***[USB Type-C 1.3]***). During Cable Plug discovery, when there is an Explicit Contract, ***Discover Identity*** Commands are sent at a rate defined by the ***DiscoverIdentityTimer*** (see Section 6.6.14) up to a maximum of ***nDiscoverIdentityCount*** times (see Section 6.7.5).

Claim	Identification

The ***Discover Identity*** Command ACK sent back by the Responder ***Shall*** contain an ID Header VDO, a Cert Stat VDO, a Product VDO and the Product Type VDOs defined by the Product Type as shown in Figure 6-15. This specification defines the following Product Type VDOs:

- Passive Cable VDO (see Section 6.4.4.3.1.4)
- Active Cable VDOs (see Section 6.4.4.3.1.5)
- Alternate Mode Adapter VDO (see Section 6.4.4.3.1.6)
- VCONN Powered USB Device VDO (see Section 6.4.4.3.1.7)

No VDOs other than those defined in this specification ***Shall*** be sent as part of the ***Discover Identity*** Command response. Where there is no Product Type VDO defined for a specific Product Type, no VDOs ***Shall*** be sent as part of the ***Discover Identity*** Command response. Any additional VDOs received by the initiator ***Shall*** be ***Ignored***.

Figure 6-15 Discover Identity Command response

Header No. of Data Objects = 4-7[1]	VDM Header	ID Header VDO	Cert Stat VDO	Product VDO	0..3[2] Product Type VDO(s)

[1] Only Data objects defined in this specification can be sent as part of the ***Discover Identity*** Command.

[2] The following sections define the number and content of the VDOs for each Product Type.

6.4.4.3.1.1.3 Product Type (UFP)

The Product Type (UFP) field indicates the type of Product when in UFP Data Role, whether a VDO will be returned and if so the type of VDO to be returned. The Product Type indicated in the Product Type (UFP) field ***Shall*** be the closest categorization of the main functionality of the Product in UFP Data Role or "Undefined" when there is no suitable category for the product. For DRD Products this field ***Shall*** always indicate the Product Type when in UFP role regardless of the present Data Role. Table 6-30 defines the Product Type VDOs which ***Shall*** be returned.

Table 6-30 Product Types (UFP)

Product Type	Description	Product Type VDO	Reference
Undefined	***Shall*** be used where no other Product Type value is appropriate.	None	
PDUSB Hub	***Shall*** be used when the Product is a PDUSB Hub.	None	
PDUSB Peripheral	***Shall*** be used when the Product is a PDUSB Device other than a PDUSB Hub.	None	
PSD	***Shall*** be used when the Product is a PSD, e.g. power bank.	None	
Alternate Mode Adapter	***Shall*** be used when the Product is a PDUSB Device that supports one or more Alternate Modes.	AMA VDO	Section 6.4.4.3.1.6
VCONN Powered USB Device	***Shall*** be used when the Product is a PDUSB VCONN Powered USB Device.	VPD VDO	Section 6.4.4.3.1.7

Claim	Identification

6.4.4.3.1.1.4 Product Type (Cable Plug)

The Product Type (Cable Plug) field indicates the type of Product when the Product is a Cable Plug, whether a VDO will be returned and if so the type of VDO to be returned. Table 6-31 defines the Product Type VDOs which ***Shall*** be returned.

Table 6-31 Product Types (Cable Plug)

Product Type	Description	Product Type VDO	Reference
Undefined	***Shall*** be used where no other Product Type value is appropriate.	None	
Active Cable	***Shall*** be used when the Product is a cable that incorporates signal conditioning circuits.	Active Cable VDO	Section 6.4.4.3.1.5
Passive Cable	***Shall*** be used when the Product is a cable that does not incorporate signal conditioning circuits.	Passive Cable VDO	Section 6.4.4.3.1.4

6.4.4.3.1.3 Product VDO

The Product VDO contains identity information relating to the product. The fields in the Product VDO ***Shall*** be as defined in Table 6-34.

Table 6-34 Product VDO

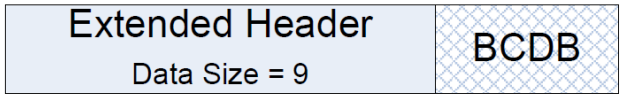
Bit(s)	Description	Reference
B31...16	16-bit unsigned integer. USB Product ID	*[USB 2.0]*/*[USB 3.2]*
B15...0	16-bit unsigned integer. bcdDevice	*[USB 2.0]*/*[USB 3.2]*

6.5.5 Battery_Capabilities Message

The ***Battery_Capabilities*** Message is sent in response to a ***Get_Battery_Cap*** Message. The ***Battery_Capabilities*** Message contains one Battery Capability Data Block (BCDB) for one of the Batteries its supports as reported by Battery field in the ***Source_Capabilities_Extended*** Message. The returned BCDB ***Shall*** correspond to the Battery requested in the ***Battery Cap Ref*** field contained in the ***Get_Battery_Cap*** Message.

The ***Battery_Capabilities*** Message returns a 9-byte BCDB whose format ***Shall*** be as shown in Figure 6-35 and Table 6-46.

Figure 6-35 Battery_Capabilities Message



Claim	Identification

Table 6-50 Battery Capability Data Block (BCDB)

Offset (Byte)	Field	Description
0	VID	Vendor ID (assigned by the USB-IF)
2	PID	Product ID (assigned by the manufacturer)
4	Battery Design Capacity	Battery's design capacity in 0.1 WH Note: 0x0000 = Battery not present 0xFFFF = design capacity unknown
6	Battery Last Full Charge Capacity	Battery's last full charge capacity in 0.1 WH Note: 0x0000 = Battery not present 0xFFFF = last full charge capacity unknown
8	Battery Type	**Bit** / **Description** 0 — Invalid Battery reference 1-7 — ***Reserved***

6.5.5.1 Battery Design Capacity Field

The Battery Design Capacity field ***Shall*** return the Battery's design capacity in tenths of WH. If the Battery is Hot Swappable and is not present, the Battery Design Capacity field ***Shall*** be set to 0. If the Battery is unable to report its Design Capacity, it ***Shall*** return 0xFFFF.

6.5.5.3 Battery Type Field

The Battery Type Field is used to report additional information about the Battery's capabilities.

6.5.7 Manufacturer_Info Message

The ***Manufacturer_Info*** Message ***Shall*** be sent in response to a ***Get_Manufacturer_Info*** Message. The ***Manufacturer_Info*** Message contains the USB VID and the Vendor's PID to identify the device or Battery and the device or Battery's manufacturer byte array in a variable length Data Block of up to ***MaxExtendedMsgLegacyLen*** .

The ***Manufacturer_Info*** Message returns a Manufacturer Info Data Block (MIDB) whose format ***Shall*** be as shown in Figure 6-35 and Table 6-46.

Claim	Identification

Figure 6-37 Manufacturer_Info Message

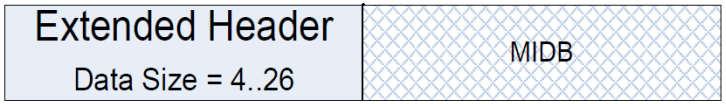


Table 6-52 Manufacturer Info Data Block (MIDB)

Offset	Field	Description
0	VID	Vendor ID (assigned by the USB-IF)
2	PID	Product ID (assigned by the manufacturer)
4	Manufacturer String	Vendor defined null terminated string of 0…21 characters If the Manufacturer Info Target field or Manufacturer Info Ref field in the ***Get_Manufacturer_Info*** Message is unrecognized return zero bytes.

6.5.7.1 **Vendor ID (VID)**

This field ***Shall*** contain the device's or Battery's16-bit vendor ID assigned by the USB.

6.5.7.2 **Product ID (PID)**

This field ***Shall*** contain the device's or Battery's 16-bit product identifier designated by the vendor.

6.5.7.3 **Manufacturer String**

This field ***Shall*** contain the device's or Battery's manufacturer string as defined by the vendor.

If the ***Manufacturer Info Target*** field or ***Manufacturer Info Ref*** field in the ***Get_Manufacturer_Info*** Message is unrecognized the field ***Shall*** return a null terminated ascii text string "Not Supported".

See, e.g., USB 3.0 Promoter Group, *USB Power Delivery Specification* (Rev. 3.0, Ver. 1.2, June 21, 2018) *available at* https://web.archive.org/web/20190212011507/https://www.usb.org/document-library/usb-power-delivery; *see also, e.g.*, *USB Power Delivery – Base Specification*, USB-IF (Oct. 31, 2023), https://www.usb.org/document-library/usb-power-delivery; usb.org, *USB Power Delivery Specification 1.0 – USB.org*, Yumpu (Nov. 24, 2012), https://www.yumpu.com/en/document/view/ 4321520/usb-power-delivery-specification-10-usborg.

Claim	Identification

USB Power Delivery 1.0, 2.0, 3.0 and 3.1 Standards - Confused yet?

There is no need to be. There are four iterations of the USB PD standard. USB PD 1.0 is a rather basic version providing fixed power profiles, whereas the newer PD 2.0, 3.0 and 3.1 revisions are more dynamic and provide greater flexibility.

USB Power Delivery 1.0

Profile	Voltage	Current	Power	Supported devices
1	5 V	2 A	10 W	smartphones, hard drives, small accessories
2	12 V	1.5 A	18 W	smartphones, tablets, Ultrabooks™, larger accessories
3	12 V	3 A	36 W	future smartphones, notebooks, displays, hubs
4	20 V	3 A	60 W	larger notebooks, hubs, docking stations
5	20 V	5 A	100 W *	workstations, hubs, external graphic cards

USB Power Delivery 2.0/3.0

Profile	Voltage	Current	Power	Supported devices
1	5 V	0.1 - 3.0 [A]	10 W	headphones, small accessories
2	9 V	1.67 - 3.0 [A]	15 - 27 W	smartphones, cameras and drones
3	15 V	1.8 - 3.0 [A]	27 - 45 W	tablets, and small laptops
4	20 V	2.25 - 3.0 [A] 3.0 - 5.0 [A] *	45 - 100 W	large laptops and displays

* Requires specially rated **100 W USB-C charging cable**

<table>
<tr><th>Claim</th><th>Identification</th></tr>
<tr><td></td><td>
USB Power Delivery 3.1
The USB PD 3.1 specification divides power into two ranges: Standard Power (SPR), which is the current USB PD3.0 standard with a maximum charging power of 100 W and Extended Power (EPR) with three newly added voltages of 28 V, 36 V, and 48 V. The maximum output current to the three voltages is still 5 A, while the maximum output power can reach 240 W.
<table>
<tr><th>Profile</th><th>Voltage</th><th>Current</th><th>Power</th><th>Supported devices</th></tr>
<tr><td>5</td><td>28 V</td><td>3.57 - 5.0 [A] *</td><td>140 W</td><td>displays, gaming laptops</td></tr>
<tr><td>6</td><td>36 V</td><td>3.89 - 5.0 [A] *</td><td>180 W</td><td>displays, gaming laptops</td></tr>
<tr><td>7</td><td>48 V</td><td>3.75 - 5.0 [A] *</td><td>240 W</td><td>displays, gaming laptops, desktop PCs</td></tr>
</table>
* Requires specially rated 240 W USB-C charging cable
See, e.g., USB-C Power Delivery, Manhattan Products, https://manhattanproducts.eu/pages/usb-c-pd-charging-everything-you-need-to-know (last visited Mar. 8, 2024).
</td></tr>
<tr><td>1[a] a charging circuit, and</td><td>
Acer-branded devices include or are accompanied by a charger including a charging circuit.

1.1 Overview
This specification defines how USB Devices can negotiate for more current and/or higher or lower voltages over the USB cable (using the USB Type-C CC wire as the communications channel) than are defined in the [USB 2.0], [USB 3.2], [USB Type-C 1.3] or [USBBC 1.2] specifications. It allows Devices with greater power requirements than can be met with today's specification to get the power they require to operate from V_{BUS} and negotiate with external power sources (e.g. Wall Warts). In addition, it allows a Source and Sink to swap power roles such that a Device could supply power to the Host. For example, a display could supply power to a notebook to charge its battery.
</td></tr>
</table>

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To facilitate optimum charging, the specification defines two mechanisms a USB Charger can advertise for the Device to use:

1. A list of fixed voltages each with a maximum current. The Device selects a voltage and current from the list. This is the traditional model used by Devices that use internal electronics to manage the charging of their battery including modifying the voltage and current actually supplied to the battery. The side-effect of this model is that the charging circuitry generates heat that may be problematic for small form factor devices.
2. A list of programmable voltage ranges each with a maximum current (PPS). The Device requests a voltage (in 20 mV increments) that is within the advertised range and a maximum current. The USB Charger delivers the requested voltage until the maximum current is reached at which time the USB charger reduces its output voltage so as not to supply more than the requested maximum current. During the high current portion of the charge cycle, the USB Charger can be directly connected (through an appropriate safety device) to the battery. This model is used by Devices that want to minimize the thermal impact of their internal charging circuitry.

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The USB Power Delivery specification defines a power delivery system covering all elements of a USB system including: Hosts, Devices, Hubs, Chargers and cable assemblies. This specification describes the architecture, protocols, power supply behavior, connectors and cabling necessary for managing power delivery over USB at up to 100W. This specification is intended to be fully compatible and extend the existing USB infrastructure. It is intended that this specification will allow system OEMs, power supply and peripheral developers adequate flexibility for product versatility and market differentiation without losing backwards compatibility.

USB Power Delivery is designed to operate independently of the existing USB bus defined mechanisms used to negotiate power which are:

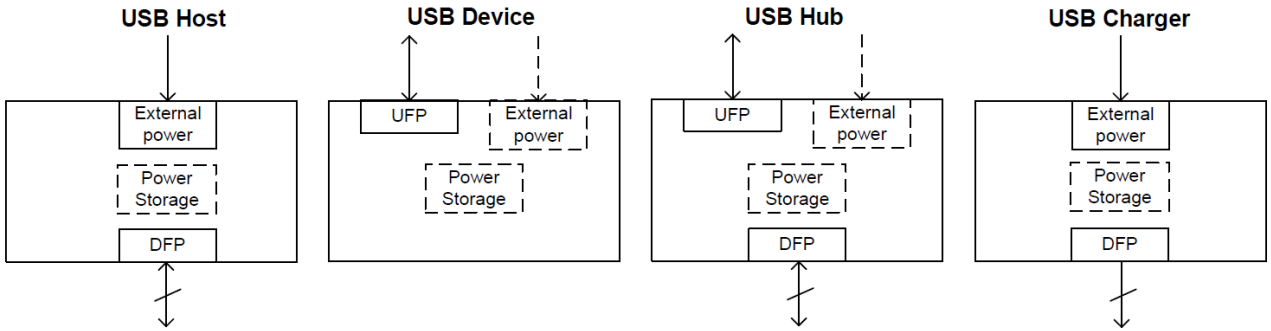
- ***[USB 2.0]***, ***[USB 3.2]*** in band requests for high power interfaces.
- ***[USBBC 1.2]*** mechanisms for supplying higher power (not mandated by this specification).
- ***[USB Type-C 1.3]*** mechanisms for supplying higher power

Claim	Identification

2.4 USB Power Delivery Capable Devices

Some examples of USB Power Delivery capable devices can be seen in Figure 2-1 (a Host, a Device, a Hub, and a Charger). These are given for reference only and do not limit the possible configurations of products that can be built using this specification.

Figure 2-1 Logical Structure of USB Power Delivery Capable Devices



2.7 Architectural Overview

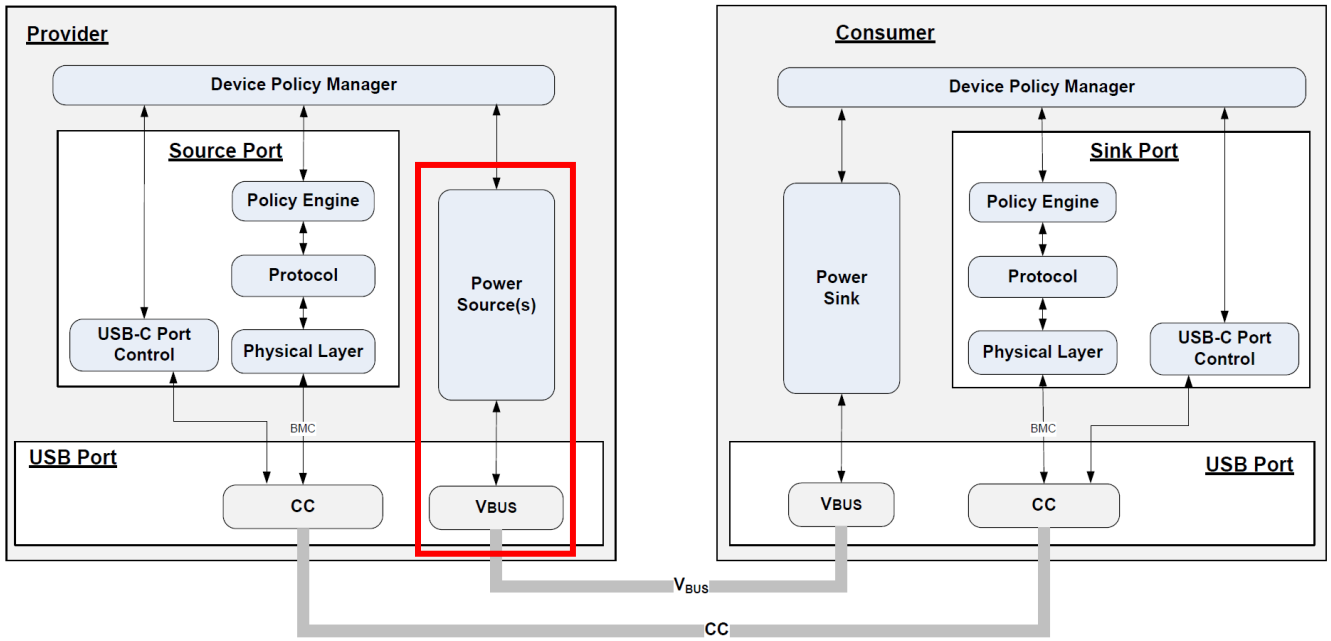
Figure 2-5 shows the logical blocks between two Attached PD ports. In addition to the communication stack described above there are also:

- For a Provider or Dual-Role Power Device: one or more **Sources** providing power to one or more ports.
- For a Consumer or Dual-Role Power Device: A **Sink** consuming power.
- A **USB-C Port Control** module (see Section4.4) that detects cable Attach/Detach as defined in ***[USB Type-C 1.3]***.
- USB Power Delivery uses standard cabling as defined in ***[USB Type-C 1.3]***.

The **Device Policy Manager** talks to the communication stack, Source/Sink and the USB-C Port Control block in order to manage the resources in the Provider or Consumer.

Claim	Identification

Figure 2-5 High Level Architecture View



See, e.g., USB 3.0 Promoter Group, USB Power Delivery Specification (Rev. 3.0, Ver. 1.2, June 21, 2018) *available at* https://web.archive.org/web/20190212011507/https://www.usb.org/document-library/usb-power-delivery; *see also, e.g.*, *USB Power Delivery – Base Specification*, USB-IF (Oct. 31, 2023), https://www.usb.org/document-library/usb-power-delivery; usb.org, *USB Power Delivery Specification 1.0 – USB.org*, Yumpu (Nov. 24, 2012), https://www.yumpu.com/en/document/view/ 4321520/usb-power-delivery-specification-10-usborg.

Claim	Identification
1[b] a controller coupled to said charging circuit and configured to cause said portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and	Acer-branded devices include or are accompanied by a charger including a controller coupled to said charging circuit and configured to cause said portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type.

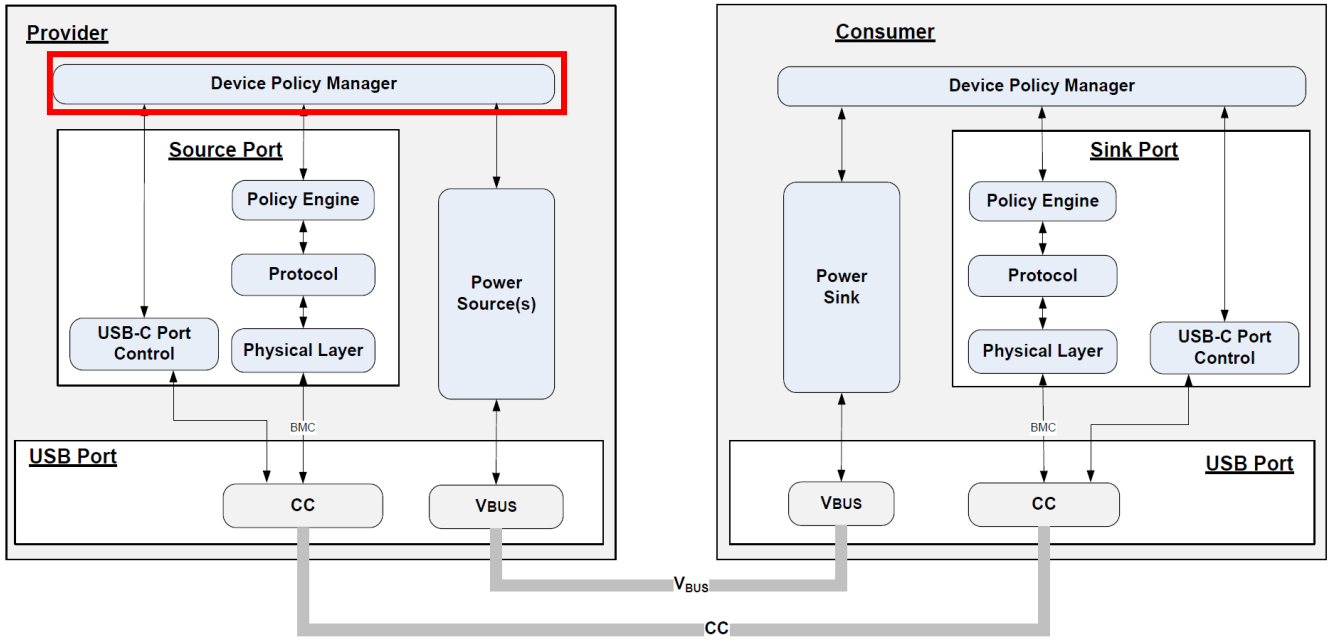
2.7 Architectural Overview

Figure 2-5 shows the logical blocks between two Attached PD ports. In addition to the communication stack described above there are also:

- For a Provider or Dual-Role Power Device: one or more **Sources** providing power to one or more ports.
- For a Consumer or Dual-Role Power Device: A **Sink** consuming power.
- A **USB-C Port Control** module (see Section4.4) that detects cable Attach/Detach as defined in ***[USB Type-C 1.3]***.
- USB Power Delivery uses standard cabling as defined in ***[USB Type-C 1.3]***.

The **Device Policy Manager** talks to the communication stack, Source/Sink and the USB-C Port Control block in order to manage the resources in the Provider or Consumer.

Figure 2-5 High Level Architecture View



Claim	Identification
	8.2 Device Policy Manager The Device Policy Manager is responsible for managing the power used by one or more USB Power Delivery ports. In order to have sufficient knowledge to complete this task it needs relevant information about the device it resides in. Firstly, it has a priori knowledge of the device including the capabilities of the power supply and the receptacles on each Port since these will for example have specific current ratings. It also has to know information from the USB-C Port Control module regarding cable insertion, type and rating of cable etc. It also has to have information from the power supply about changes in its capabilities as well as being able to request power supply changes. With all of this information the Device Policy Manager is able to provide up to date information regarding the capabilities available to a specific Port and to manage the power resources within the device. When working out the capabilities for a given Source Port the Device Policy Manager will take into account firstly the current rating of the Port's receptacle and whether the inserted cable is PD or non-PD rated and if so what is the capability of the plug. This will set an upper bound for the capabilities which might be offered. After this the Device Policy Manager will consider the available power supply resources since this will bound which voltages and currents might be offered. Finally, the Device Policy Manager will consider what power is currently allocated to other ports, which power is in the Power Reserve and any other amendments to Policy from the System Policy Manager. The Device Policy Manager will offer a set of capabilities within the bounds detailed above. When selecting a capability for a given Sink Port the Device Policy Manager will look at the capabilities offered by the Source. This will set an upper bound for the capabilities which might be requested. The Device Policy Manager will also consider which capabilities are required by the Sink in order to operate. If an appropriate match for Voltage and Current can be found within the limits of the receptacle and cable then this will be requested from the Source. If an appropriate match cannot be found then a request for an offered voltage and current will be made, along with an indication of a capability mismatch. **8.2.1 Capabilities** The Device Policy Manager in a Provider ***Shall*** know the power supplies available in the device and their capabilities. In addition, it ***Shall*** be aware of any other PD Sources of power such as batteries and AC inputs. The available power sources and existing demands on the device ***Shall*** be taken into account when presenting capabilities to a Sink. The Device Policy Manager in a Consumer ***Shall*** know the requirements of the Sink and use this to evaluate the capabilities offered by a Source. It ***Shall*** be aware of its own power sources e.g. Batteries or AC supplies where these have a bearing on its operation as a Sink. The Device Policy Manager in a Dual-Role Power Device ***Shall*** combine the above capabilities and ***Shall*** also be able to present the dual-role nature of the device to an Attached PD Capable device.

Claim	Identification

	8.2.3 Control of Source/Sink
	
	The Device Policy Manager for a Provider ***Shall*** manage the power supply for each PD Source Port and ***Shall*** know at any given time what the negotiated power is. It ***Shall*** request transitions of the supply and inform the Policy Engine whenever a transition completes.
	
	The Device Policy Manager for a Consumer ***Shall*** manage the Sink for each PD Sink Port and ***Shall*** know at any given time what the negotiated power is.
	
	The Device Policy Manager for a Dual-Role Power Device ***Shall*** manage the transition between Source/Sink roles for each PD Dual-Role Power Port and ***Shall*** know at any given time what operational role the Port is in.
	
	8.3.2.2 Power Negotiation
	
	8.3.2.2.1 Explicit Contract Negotiation
	
	Figure 8-5 illustrates an example of a successful Message flow while negotiating an Explicit Contract. The negotiation goes through 5 distinct phases:
	
	• The Source sends out its power capabilities in a ***Source_Capabilities*** Message.
	• The Sink evaluates these capabilities and in the request phase selects one power level by sending a ***Request*** Message.
	• The Source evaluates the request and accepts the request with an ***Accept*** Message.
	• The Source transitions to the new power level and then informs the Sink by sending a ***PS_RDY*** Message.
	• The Sink starts using the new power level.
	• For PPS operation:
	  ○ the Source starts its keep alive timer
	  ○ the Sink starts its request timer to send periodic ***Request*** Messages
	
	6.4.2 Request Message
	
	A ***Request*** Message ***Shall*** be sent by a Sink to request power, typically during the request phase of a power negotiation. The Request Data Object ***Shall*** be returned by the Sink making a request for power. It ***Shall*** be sent in response to the most recent ***Source_Capabilities*** Message (see Section 8.3.2.2). A ***Request*** Message ***Shall*** return one and only one Sink Request Data Object that ***Shall*** identify the Power Data Object being requested.
	
	The ***Request*** Message includes the requested power level. For example, if the ***Source_Capabilities*** Message includes a Fixed Supply PDO that offers 12V @ 1.5A and if the Sink only wants 12V @ 0.5A, it will set the Operating Current field to 50 (i.e. 10mA * 50 = 0.5A). The ***Request*** Message requests the highest current the Sink will ever require in the Maximum Operating Current Field (in this example it would be 100 (100 * 10mA = 1.0A)).

Claim	Identification

6.4.2.3 Capability Mismatch

A Capability Mismatch occurs when the Sink cannot satisfy its power requirements from the capabilities offered by the Source. In this case the Sink ***Shall*** make a ***Valid*** request from the offered capabilities and ***Shall*** set the Capability Mismatch bit (see Section 8.2.5.2).

When a Sink returns a Request Data Object in response to advertised capabilities with this bit set, it indicates that the Sink wants power that the Source cannot provide. This can be due to either a voltage that is not available or the amount of available current. At this point the Source can use the information in the ***Request*** Message combined with the contents of the ***Sink_Capabilities*** Message to ascertain the Voltage and Current required by the Sink for full operation.

In this context a ***Valid Request*** Message means the following:

- The Object position field ***Shall*** contain a reference to an object in the last received ***Source_Capabilities*** Message.
- The Operating Current/Power field ***Shall*** contain a value which is less than or equal to the maximum current/power offered in the ***Source_Capabilities*** Message.
- If the GiveBack flag is set to zero i.e. there is a Maximum Operating Current/Power field:
  - If the Capability Mismatch bit is set to one:
    - The Maximum Operating Current/Power field ***May*** contain a value larger than the maximum current/power offered in the ***Source_Capabilities*** Message's PDO as referenced by the Object position field. This enables the Sink to indicate that it requires more current/power than is being offered. If the Sink requires a different voltage this will be indicated by its ***Sink_Capabilities*** Message.
  - Else if the Capability Mismatch bit is set to zero:
    - The Maximum Operating Current/Power field ***Shall*** contain a value less than or equal to the maximum current/power offered in the ***Source_Capabilities*** Message's PDO as referenced by the Object position field.
- Else if the GiveBack flag is set to one i.e. there is a Minimum Operating Current/Power field:
  - The Minimum Operating Current/Power field ***Shall*** contain a value less than the Operating Current/Power field.

6.4.1.3 Sink Capabilities Message

A Sink Port ***Shall*** report power levels it is able to operate at in a series of 32-bit Power Data Objects (see Table 6-7). These are returned as part of a ***Sink_Capabilities*** Message in response to a ***Get_Sink_Cap*** Message (see Figure 6-12). This is similar to that used for Source Port capabilities with equivalent Power Data Objects for Fixed, Variable and Battery Supplies as defined in this section. Power Data Objects are used to convey the Sink Port's operational power requirements including Dual-Role Power Ports presently operating as a Source.

Each Power Data Object ***Shall*** describe a specific Sink operational power level, such as a Battery (e.g. 2.8-4.1V) or a fixed power supply (e.g. 12V). The ***Number of Data Objects*** field in the Message Header ***Shall*** define the number of Power Data Objects that follow the Message Header in a Data Message.

Claim	Identification

All Sinks ***Shall*** minimally offer one Power Data Object with a power level at which the Sink can operate. A Sink ***Shall Not*** offer multiple Power Data Objects of the same type (fixed, variable, Battery) and the same voltage but ***Shall*** instead offer one Power Data Object with the highest available current for that Sink capability and voltage.

All Sinks ***Shall*** include one Power Data Object that reports ***vSafe5V*** even if they require additional power to operate fully. In the case where additional power is required for full operation the Higher Capability bit ***Shall*** be set.

6.4.1.3.1 Sink Fixed Supply Power Data Object

Table 6-14 describes the Sink Fixed Supply (00b) PDO. See Section 7.1.3 for the electrical requirements of the power supply. The Sink ***Shall*** set Voltage to its required voltage and Operational Current to its required operating current. Required operating current is defined as the amount of current a given device needs to be functional. This value could be the maximum current the Sink will ever require or could be sufficient to operate the Sink in one of its modes of operation.

Since all USB Consumers support ***vSafe5V***, the required ***vSafe5V*** Fixed Supply Power Data Object is also used to convey additional information that is returned in bits 29 through 20. All other Fixed Supply Power Data Objects ***Shall*** set bits 29...20 to zero.

For a Sink requiring no power from the Source, the Voltage (B19...10) ***Shall*** be set to 5V and the Operational Current ***Shall*** be set to 0mA.

Table 6-14 Fixed Supply PDO - Sink

Bit(s)	Description
B31...30	Fixed supply
B29	Dual-Role Power
B28	Higher Capability
B27	Unconstrained Power
B26	USB Communications Capable
B25	Dual-Role Data
B24...23	Fast Role Swap required USB Type-C Current (see also ***[USB Type-C 1.3]***):
B22...20	***Reserved – Shall*** be set to zero.
B19...10	Voltage in 50mV units
B9...0	Operational Current in 10mA units

Value	Description
00b	Fast Swap not supported (default)
01b	Default USB Power
10b	1.5A @ 5V
11b	3.0A @ 5V

Claim	Identification

8.2.4 Cable Detection

8.2.4.1 Device Policy Manager in a Provider

The Device Policy Manager in the Provider ***Shall*** control the USB-C Port Control module and ***Shall*** be able to use the USB-C Port Control module to determine the Attachment status.

Note: that it might be necessary for the Device Policy Manager to also initiate additional discovery using the ***Discover Identity*** Command in order to determine the full capabilities of the cabling (see Section 6.4.4.2).

6.4.4.3.1 Discover Identity

The ***Discover Identity*** Command is provided to enable an Initiator to identify its Port Partner and for an Initiator (VCONN Source) to identify the Responder (Cable Plug). The ***Discover Identity*** Command is also used to determine whether a Cable Plug is PD-Capable by looking for a ***GoodCRC*** Message Response.

The ***Discover Identity*** Command ***Shall*** be used to determine whether a given Cable Plug is PD Capable (see Section 8.3.3.18.1 and Section 8.3.3.22.3). In this case a ***Discover Identity*** Command request sent to SOP' ***Shall Not*** cause a Soft Reset if a ***GoodCRC*** Message response is not returned since this can indicate a non-PD Capable cable. Note that a Cable Plug will not be ready for PD Communication until tVCONNStable after VCONN has been applied (see ***[USB Type-C 1.3]***). During Cable Plug discovery, when there is an Explicit Contract, ***Discover Identity*** Commands are sent at a rate defined by the ***DiscoverIdentityTimer*** (see Section 6.6.14) up to a maximum of ***nDiscoverIdentityCount*** times (see Section 6.7.5).

The ***Discover Identity*** Command ACK sent back by the Responder ***Shall*** contain an ID Header VDO, a Cert Stat VDO, a Product VDO and the Product Type VDOs defined by the Product Type as shown in Figure 6-15. This specification defines the following Product Type VDOs:

- Passive Cable VDO (see Section 6.4.4.3.1.4)
- Active Cable VDOs (see Section 6.4.4.3.1.5)
- Alternate Mode Adapter VDO (see Section 6.4.4.3.1.6)
- VCONN Powered USB Device VDO (see Section 6.4.4.3.1.7)

No VDOs other than those defined in this specification ***Shall*** be sent as part of the ***Discover Identity*** Command response. Where there is no Product Type VDO defined for a specific Product Type, no VDOs ***Shall*** be sent as part of the ***Discover Identity*** Command response. Any additional VDOs received by the initiator ***Shall*** be ***Ignored***.

Figure 6-15 Discover Identity Command response

Header No. of Data Objects = 4-7[1]	VDM Header	ID Header VDO	Cert Stat VDO	Product VDO	0..3[2] Product Type VDO(s)

[1] Only Data objects defined in this specification can be sent as part of the ***Discover Identity*** Command.

[2] The following sections define the number and content of the VDOs for each Product Type.

Claim	Identification

6.4.4.3.1.1.3 Product Type (UFP)

The Product Type (UFP) field indicates the type of Product when in UFP Data Role, whether a VDO will be returned and if so the type of VDO to be returned. The Product Type indicated in the Product Type (UFP) field ***Shall*** be the closest categorization of the main functionality of the Product in UFP Data Role or "Undefined" when there is no suitable category for the product. For DRD Products this field ***Shall*** always indicate the Product Type when in UFP role regardless of the present Data Role. Table 6-30 defines the Product Type VDOs which ***Shall*** be returned.

Table 6-30 Product Types (UFP)

Product Type	Description	Product Type VDO	Reference
Undefined	***Shall*** be used where no other Product Type value is appropriate.	None	
PDUSB Hub	***Shall*** be used when the Product is a PDUSB Hub.	None	
PDUSB Peripheral	***Shall*** be used when the Product is a PDUSB Device other than a PDUSB Hub.	None	
PSD	***Shall*** be used when the Product is a PSD, e.g. power bank.	None	
Alternate Mode Adapter	***Shall*** be used when the Product is a PDUSB Device that supports one or more Alternate Modes.	AMA VDO	Section 6.4.4.3.1.6
VCONN Powered USB Device	***Shall*** be used when the Product is a PDUSB VCONN Powered USB Device.	VPD VDO	Section 6.4.4.3.1.7

6.4.4.3.1.1.4 Product Type (Cable Plug)

The Product Type (Cable Plug) field indicates the type of Product when the Product is a Cable Plug, whether a VDO will be returned and if so the type of VDO to be returned. Table 6-31 defines the Product Type VDOs which ***Shall*** be returned.

Table 6-31 Product Types (Cable Plug)

Product Type	Description	Product Type VDO	Reference
Undefined	***Shall*** be used where no other Product Type value is appropriate.	None	
Active Cable	***Shall*** be used when the Product is a cable that incorporates signal conditioning circuits.	Active Cable VDO	Section 6.4.4.3.1.5
Passive Cable	***Shall*** be used when the Product is a cable that does not incorporate signal conditioning circuits.	Passive Cable VDO	Section 6.4.4.3.1.4

Claim	Identification

6.4.4.3.1.3 Product VDO

The Product VDO contains identity information relating to the product. The fields in the Product VDO ***Shall*** be as defined in Table 6-34.

Table 6-34 Product VDO

Bit(s)	Description	Reference
B31...16	16-bit unsigned integer. USB Product ID	*[USB 2.0]/[USB 3.2]*
B15...0	16-bit unsigned integer. bcdDevice	*[USB 2.0]/[USB 3.2]*

6.5.5 Battery_Capabilities Message

The ***Battery_Capabilities*** Message is sent in response to a ***Get_Battery_Cap*** Message. The ***Battery_Capabilities*** Message contains one Battery Capability Data Block (BCDB) for one of the Batteries its supports as reported by Battery field in the ***Source_Capabilities_Extended*** Message. The returned BCDB ***Shall*** correspond to the Battery requested in the ***Battery Cap Ref*** field contained in the ***Get_Battery_Cap*** Message.

The ***Battery_Capabilities*** Message returns a 9-byte BCDB whose format ***Shall*** be as shown in Figure 6-35 and Table 6-46.

Figure 6-35 Battery_Capabilities Message

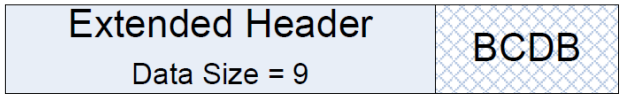


Table 6-50 Battery Capability Data Block (BCDB)

Offset (Byte)	Field	Description
0	VID	Vendor ID (assigned by the USB-IF)
2	PID	Product ID (assigned by the manufacturer)
4	Battery Design Capacity	Battery's design capacity in 0.1 WH Note: 0x0000 = Battery not present 0xFFFF = design capacity unknown
6	Battery Last Full Charge Capacity	Battery's last full charge capacity in 0.1 WH Note: 0x0000 = Battery not present 0xFFFF = last full charge capacity unknown

Claim	Identification

8	Battery Type	

Bit	Description
0	Invalid Battery reference
1-7	***Reserved***

6.5.5.1 Battery Design Capacity Field

The Battery Design Capacity field ***Shall*** return the Battery's design capacity in tenths of WH. If the Battery is Hot Swappable and is not present, the Battery Design Capacity field ***Shall*** be set to 0. If the Battery is unable to report its Design Capacity, it ***Shall*** return 0xFFFF.

6.5.5.3 Battery Type Field

The Battery Type Field is used to report additional information about the Battery's capabilities.

6.5.7 Manufacturer_Info Message

The ***Manufacturer_Info*** Message ***Shall*** be sent in response to a ***Get_Manufacturer_Info*** Message. The ***Manufacturer_Info*** Message contains the USB VID and the Vendor's PID to identify the device or Battery and the device or Battery's manufacturer byte array in a variable length Data Block of up to ***MaxExtendedMsgLegacyLen*** .

The ***Manufacturer_Info*** Message returns a Manufacturer Info Data Block (MIDB) whose format ***Shall*** be as shown in Figure 6-35 and Table 6-46.

Figure 6-37 Manufacturer_Info Message

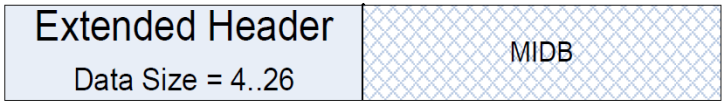


Table 6-52 Manufacturer Info Data Block (MIDB)

Offset	Field	Description
0	VID	Vendor ID (assigned by the USB-IF)
2	PID	Product ID (assigned by the manufacturer)
4	Manufacturer String	Vendor defined null terminated string of 0…21 characters If the Manufacturer Info Target field or Manufacturer Info Ref field in the ***Get_Manufacturer_Info*** Message is unrecognized return zero bytes.

Claim	Identification
	6.5.7.1 **Vendor ID (VID)** This field ***Shall*** contain the device's or Battery's16-bit vendor ID assigned by the USB. 6.5.7.2 **Product ID (PID)** This field ***Shall*** contain the device's or Battery's 16-bit product identifier designated by the vendor. 6.5.7.3 **Manufacturer String** This field ***Shall*** contain the device's or Battery's manufacturer string as defined by the vendor. If the ***Manufacturer Info Target*** field or ***Manufacturer Info Ref*** field in the ***Get_Manufacturer_Info*** Message is unrecognized the field ***Shall*** return a null terminated ascii text string "Not Supported". *See, e.g.*, USB 3.0 Promoter Group, *USB Power Delivery Specification* (Rev. 3.0, Ver. 1.2, June 21, 2018) *available at* https://web.archive.org/web/20190212011507/https://www.usb.org/document-library/usb-power-delivery; *see also, e.g.*, *USB Power Delivery – Base Specification*, USB-IF (Oct. 31, 2023), https://www.usb.org/document-library/usb-power-delivery; usb.org, *USB Power Delivery Specification 1.0 – USB.org*, Yumpu (Nov. 24, 2012), https://www.yumpu.com/en/document/view/ 4321520/usb-power-delivery-specification-10-usborg.

1[c] to cause said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.	Acer-branded devices include or are accompanied by a charger including a controller coupled to said charging circuit and configured to cause said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.
	8.3.2.2 **Power Negotiation**
	8.3.2.2.1 Explicit Contract Negotiation
	Figure 8-5 illustrates an example of a successful Message flow while negotiating an Explicit Contract. The negotiation goes through 5 distinct phases:
	• The Source sends out its power capabilities in a ***Source_Capabilities*** Message.
	• The Sink evaluates these capabilities and in the request phase selects one power level by sending a ***Request*** Message.
	• The Source evaluates the request and accepts the request with an ***Accept*** Message.
	• The Source transitions to the new power level and then informs the Sink by sending a ***PS_RDY*** Message.
	• The Sink starts using the new power level.
	• For PPS operation:
	  ○ the Source starts its keep alive timer
	  ○ the Sink starts its request timer to send periodic ***Request*** Messages

Claim	Identification
	6.4.1.3 Sink Capabilities Message A Sink Port ***Shall*** report power levels it is able to operate at in a series of 32-bit Power Data Objects (see Table 6-7). These are returned as part of a ***Sink_Capabilities*** Message in response to a ***Get_Sink_Cap*** Message (see Figure 6-12). This is similar to that used for Source Port capabilities with equivalent Power Data Objects for Fixed, Variable and Battery Supplies as defined in this section. Power Data Objects are used to convey the Sink Port's operational power requirements including Dual-Role Power Ports presently operating as a Source. Each Power Data Object ***Shall*** describe a specific Sink operational power level, such as a Battery (e.g. 2.8-4.1V) or a fixed power supply (e.g. 12V). The ***Number of Data Objects*** field in the Message Header ***Shall*** define the number of Power Data Objects that follow the Message Header in a Data Message. All Sinks ***Shall*** minimally offer one Power Data Object with a power level at which the Sink can operate. A Sink ***Shall Not*** offer multiple Power Data Objects of the same type (fixed, variable, Battery) and the same voltage but ***Shall*** instead offer one Power Data Object with the highest available current for that Sink capability and voltage. All Sinks ***Shall*** include one Power Data Object that reports ***vSafe5V*** even if they require additional power to operate fully. In the case where additional power is required for full operation the Higher Capability bit ***Shall*** be set. 6.4.1.3.1 Sink Fixed Supply Power Data Object Table 6-14 describes the Sink Fixed Supply (00b) PDO. See Section 7.1.3 for the electrical requirements of the power supply. The Sink ***Shall*** set Voltage to its required voltage and Operational Current to its required operating current. Required operating current is defined as the amount of current a given device needs to be functional. This value could be the maximum current the Sink will ever require or could be sufficient to operate the Sink in one of its modes of operation. Since all USB Consumers support ***vSafe5V***, the required ***vSafe5V*** Fixed Supply Power Data Object is also used to convey additional information that is returned in bits 29 through 20. All other Fixed Supply Power Data Objects ***Shall*** set bits 29…20 to zero. For a Sink requiring no power from the Source, the Voltage (B19…10) ***Shall*** be set to 5V and the Operational Current ***Shall*** be set to 0mA.

Claim	Identification

Table 6-14 Fixed Supply PDO - Sink

Bit(s)	Description
B31...30	Fixed supply
B29	Dual-Role Power
B28	Higher Capability
B27	Unconstrained Power
B26	USB Communications Capable
B25	Dual-Role Data
B24...23	Fast Role Swap required USB Type-C Current (see also *[USB Type-C 1.3]*): Value / Description 00b – Fast Swap not supported (default) 01b – Default USB Power 10b – 1.5A @ 5V 11b – 3.0A @ 5V
B22...20	***Reserved – Shall*** be set to zero.
B19...10	Voltage in 50mV units
B9...0	Operational Current in 10mA units

6.4.2 Request Message

A ***Request*** Message ***Shall*** be sent by a Sink to request power, typically during the request phase of a power negotiation. The Request Data Object ***Shall*** be returned by the Sink making a request for power. It ***Shall*** be sent in response to the most recent ***Source_Capabilities*** Message (see Section 8.3.2.2). A ***Request*** Message ***Shall*** return one and only one Sink Request Data Object that ***Shall*** identify the Power Data Object being requested.

The ***Request*** Message includes the requested power level. For example, if the ***Source_Capabilities*** Message includes a Fixed Supply PDO that offers 12V @ 1.5A and if the Sink only wants 12V @ 0.5A, it will set the Operating Current field to 50 (i.e. 10mA * 50 = 0.5A). The ***Request*** Message requests the highest current the Sink will ever require in the Maximum Operating Current Field (in this example it would be 100 (100 * 10mA = 1.0A)).

6.4.2.3 Capability Mismatch

A Capability Mismatch occurs when the Sink cannot satisfy its power requirements from the capabilities offered by the Source. In this case the Sink ***Shall*** make a ***Valid*** request from the offered capabilities and ***Shall*** set the Capability Mismatch bit (see Section 8.2.5.2).

When a Sink returns a Request Data Object in response to advertised capabilities with this bit set, it indicates that the Sink wants power that the Source cannot provide. This can be due to either a voltage that is not available or the amount of available current. At this point the Source can use the information in the ***Request*** Message combined with the contents of the ***Sink_Capabilities*** Message to ascertain the Voltage and Current required by the Sink for full operation.

Claim	Identification

In this context a ***Valid Request*** Message means the following:

- The Object position field ***Shall*** contain a reference to an object in the last received ***Source_Capabilities*** Message.

- The Operating Current/Power field ***Shall*** contain a value which is less than or equal to the maximum current/power offered in the ***Source_Capabilities*** Message.
- If the GiveBack flag is set to zero i.e. there is a Maximum Operating Current/Power field:
  - If the Capability Mismatch bit is set to one:
    - The Maximum Operating Current/Power field ***May*** contain a value larger than the maximum current/power offered in the ***Source_Capabilities*** Message's PDO as referenced by the Object position field. This enables the Sink to indicate that it requires more current/power than is being offered. If the Sink requires a different voltage this will be indicated by its ***Sink_Capabilities*** Message.
  - Else if the Capability Mismatch bit is set to zero:
    - The Maximum Operating Current/Power field ***Shall*** contain a value less than or equal to the maximum current/power offered in the ***Source_Capabilities*** Message's PDO as referenced by the Object position field.
- Else if the GiveBack flag is set to one i.e. there is a Minimum Operating Current/Power field:
  - The Minimum Operating Current/Power field ***Shall*** contain a value less than the Operating Current/Power field.

10.2.2 Normative Voltages and Currents

The voltages and currents a Source with a PDP Rating of x Watts ***Shall*** support are as defined in Table 10-2.

Table 10-2 Normative Voltages and Minimum Currents

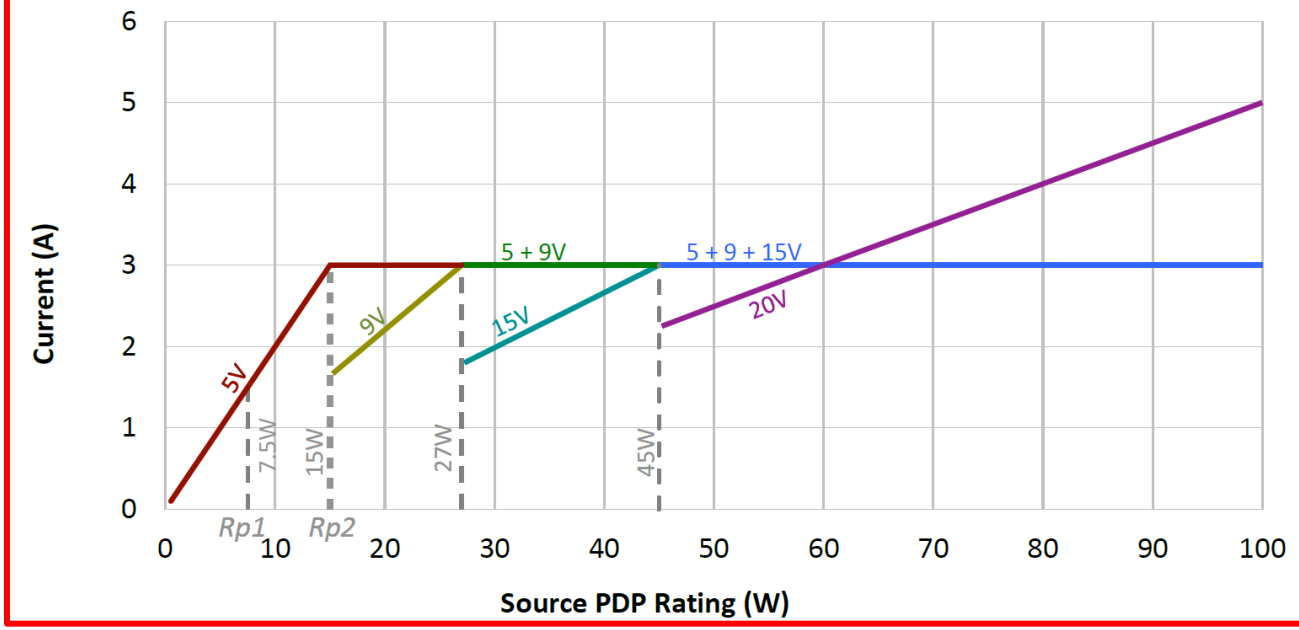
PDP Rating (W)	Current at 5V (A)	Current at 9V (A)	Current at 15V (A)	Current at 20V (A)
0.5 ≤ x ≤ 15	x ÷ 5			
15 < x ≤ 27	3	x ÷ 9		
27 < x ≤ 45	3	3	x ÷ 15	
45 < x ≤ 60	3	3	3	x ÷ 20
60 < x ≤ 100	3	3	3	x ÷ 20[1]

[1] Requires a 5A cable.

Claim	Identification

Figure 10-1 illustrates the minimum current that a Source ***Shall*** support at each voltage for a given PDP Rating. Note: Not illustrated are that currents higher than 3A are allowed to be offered up to a limit of 5A given that a 5A cable is detected by the Source and the voltage times current remains within the Source PDP Rating.

Figure 10-1 Source Power Rule Illustration



10.2.3.2 **Optional Normative Programmable Power Supply**

The voltages and currents a Programmable Power Supply with a PDP Rating of x Watts ***Shall*** support are as defined Table 10-7.

When ***Optional*** Programmable Power Supply APDOs are offered, the following requirements ***Shall*** apply:

- A Source that advertises ***Optional*** Programmable Power Supply APDOs ***Shall*** advertise the PDOs and APDOs shown in Table 10-7.
- A Source ***Shall*** advertise ***Optional*** Programmable Power Supply APDOs with Maximum Voltage and Minimum Voltages for nominal voltage as defined in Table 10-8.
- A Source that advertises Programmable Power Supply APDOs other than the ones listed in Table 10-8 ***Shall*** advertise additional APDO's with a maximum current of RoundDown (x/Max Voltage) to the nearest 50mA.
- In no case ***Shall*** a Source advertise a current that exceeds the attached cable's current rating.

Claim	Identification

Table 10-7 Programmable Power Supply PDOs and APDOs based on the PDP

PDP Rating (W)	5V fixed	9V fixed	15V fixed	20V fixed	5V Prog	9V Prog	15V Prog	20V Prog
x < 15W	PDP/5[4]	-	-	-	PDP/5[1]	-	-	-
15W	3A	-	-	-	3A	-	-	-
15 < x < 27W	3A[3]	PDP/9[4]	-	-	3A[2]	PDP/9[1]	-	-
27W	3A[3]	3A	-	-	-	3A	-	-
27 < x < 45W	3A[3]	3A[3]	PDP/15[4]	-	-	3A[2]	PDP/15[1]	-
45W	3A[3]	3A[3]	3A	-	-	-	3A	-
45 < x < 60W	3A[3]	3A[3]	3A[3]	PDP/20[4]	-	-	3A[2]	PDP/20[1]
60W	3A[3]	3A[3]	3A[3]	3A[3]	-	-	-	3A
60 < x < 100W	3A[3]	3A[3]	3A[3]	PDP/20[4]	-	-	-	PDP/20[2]
100W	3A[3]	3A[3]	3A[3]	5A	-	-	-	5A

Notes:
1. The PPS APDOs Maximum Current field ***Shall*** advertise RoundDown (PDP/Prog Voltage) to the nearest 50mA.
2. The PPS APDOs Maximum Current field ***Shall*** advertise at least 3A, but ***May*** advertise up to RoundDown(PDP/Prog voltage) to the nearest 50mA.
3. The Fixed PDOs Maximum Current field ***Shall*** advertise at least 3A, but ***May*** advertise up to RoundUp (PDP/voltage.) to the nearest 10mA.
4. The Fixed PDOs Maximum Current field ***Shall*** advertise either RoundDown (PDP/Voltage) or RoundUp (PDP/Voltage) to the nearest 10mA.

See, e.g., USB 3.0 Promoter Group, USB Power Delivery Specification (Rev. 3.0, Ver. 1.2, June 21, 2018) *available at* https://web.archive.org/web/20190212011507/https://www.usb.org/document-library/usb-power-delivery; *see also, e.g.*, *USB Power Delivery – Base Specification*, USB-IF (Oct. 31, 2023), https://www.usb.org/document-library/usb-power-delivery; usb.org, *USB Power Delivery Specification 1.0 – USB.org*, Yumpu (Nov. 24, 2012), https://www.yumpu.com/en/document/view/ 4321520/usb-power-delivery-specification-10-usborg.

Claim	Identification

USB Power Delivery 1.0, 2.0, 3.0 and 3.1 Standards - Confused yet?

There is no need to be. There are four iterations of the USB PD standard. USB PD 1.0 is a rather basic version providing fixed power profiles, whereas the newer PD 2.0, 3.0 and 3.1 revisions are more dynamic and provide greater flexibility.

USB Power Delivery 1.0

Profile	Voltage	Current	Power	Supported devices
1	5 V	2 A	10 W	smartphones, hard drives, small accessories
2	12 V	1.5 A	18 W	smartphones, tablets, Ultrabooks™, larger accessories
3	12 V	3 A	36 W	future smartphones, notebooks, displays, hubs
4	20 V	3 A	60 W	larger notebooks, hubs, docking stations
5	20 V	5 A	100 W *	workstations, hubs, external graphic cards

USB Power Delivery 2.0/3.0

Profile	Voltage	Current	Power	Supported devices
1	5 V	0.1 - 3.0 [A]	10 W	headphones, small accessories
2	9 V	1.67 - 3.0 [A]	15 - 27 W	smartphones, cameras and drones
3	15 V	1.8 - 3.0 [A]	27 - 45 W	tablets, and small laptops
4	20 V	2.25 - 3.0 [A] 3.0 - 5.0 [A] *	45 - 100 W	large laptops and displays

* Requires specially rated **100 W USB-C charging cable**

Claim	Identification
	USB Power Delivery 3.1 The USB PD 3.1 specification divides power into two ranges: Standard Power (SPR), which is the current USB PD3.0 standard with a maximum charging power of 100 W and Extended Power (EPR) with three newly added voltages of 28 V, 36 V, and 48 V. The maximum output current to the three voltages is still 5 A, while the maximum output power can reach 240 W.

Profile	Voltage	Current	Power	Supported devices
5	28 V	3.57 - 5.0 [A] *	140 W	displays, gaming laptops
6	36 V	3.89 - 5.0 [A] *	180 W	displays, gaming laptops
7	48 V	3.75 - 5.0 [A] *	240 W	displays, gaming laptops, desktop PCs

* Requires specially rated 240 W USB-C charging cable

See, e.g., USB-C Power Delivery, Manhattan Products, https://manhattanproducts.eu/pages/usb-c-pd-charging-everything-you-need-to-know (last visited Mar. 8, 2024).